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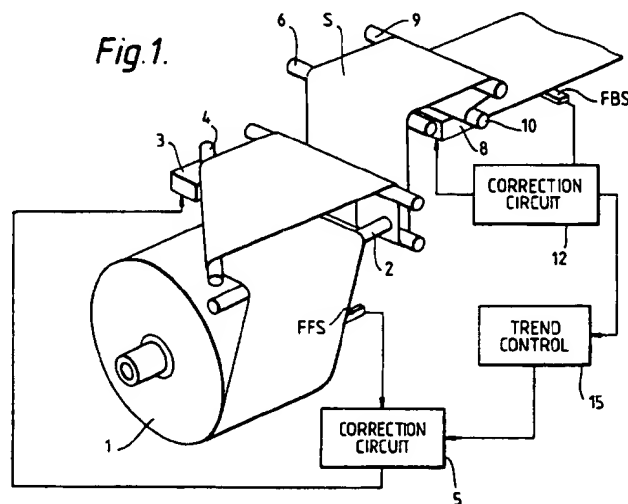
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**London EC2M 7LH (GB)**(54) **Apparatus for correcting zigzag motion of an elongated traveling web.**

(57) An apparatus for correcting zigzag motion of a longitudinally traveling elongate sheet (S) includes a feed forward sensor (FFS) on the travel path of the sheet and a feed forward correction mechanism (3) which is on the downstream side of, and is controlled by an open-loop method according to output signals from, this feed forward sensor to quickly correct the lateral displacement of the sheet. A feedback correction mechanism (9,10) on the down-

stream side is controlled by output signals from a feedback sensor (FBS) disposed further downstream thereto to correct by a closed-loop method the error in the correction effected by the first correction mechanism. If a significant trend of the sheet to move laterally in one direction is detected, parameters in the algorithm used by the feed forward correction mechanism are adjusted.

*Fig.1.***EP 0 606 731 A1**

This invention relates to apparatus for correcting zigzag motion of an elongated web, such as an elongated film or a sheet-like material, which is being transported longitudinally.

Consider, for example, a vertical pillow-type packaging machine having installed thereon a sheet roll with an elongated printed sheet wound therearound. Such a sheet is not always uniformly wound in the lateral direction because its thickness may not be uniform in the direction or there were variations in its tension when it was being wound. When such a sheet roll is set on a packaging machine and a sheet is pulled out of it, there may result a zigzag motion of the sheet, and the designs and characters printed on the produced bags may not match between the left-hand and right-hand halves. In order to prevent such occurrences, a so-called feedback mechanism may be used inclusive of a sensor placed along the travel path of the sheet and a feedback correcting means placed on the upstream side of the sensor for shifting the sheet by a closed-loop correction algorithm. Such a mechanism as described, for example, in U.S. Patent No. 4,049,213 may be effective if the irregularities in the winding of the rolled sheet vary relatively slowly. If the displacements of the sheet in the lateral direction vary significantly, however, there may be situations where a correction has already been effected by the correcting mechanism on the upstream side of the sensor by the time the displacement is detected at a downstream position. In other words, the zigzag motion of the web may become increased, instead of being reduced, by a feedback correction based on displacements detected on the downstream side.

The present invention has been accomplished in view of problems such as described above. It is therefore an object of the invention to provide a new apparatus for quickly and accurately correcting the zigzag motion of an elongated sheet caused, for example, by disarrangements in its winding around a film roll.

An apparatus embodying the present invention, with which the above and other objects can be accomplished, may be characterized as comprising a feed forward correcting means, disposed on the travel path of a longitudinally travelling elongated web, for correcting its lateral displacements, such as a turn bar disposed diagonally to the travel path so as to change the direction of the travel path approximately by 90 degrees, and a feed forward sensor means on the upstream side of the correcting means for detecting a lateral displacement of the web, the correction means changing by an open-loop method the lateral position of the web according to the outputs from the sensor means indicative of the measured displacement.

In order to further adjust the lateral displacements of the web, a second correcting means (feedback correcting means) may be employed on the downstream side of the feed forward correcting means. A feedback sensor means also for detecting a lateral displacement of the web is disposed on its downstream side such that adjustments of the lateral position of the web can be effected by a closed-loop method. Generally, corrections made by the feedback correcting means are smaller than those by the feed forward correcting means. A trend control means may be provided for adjusting control parameters of the feed forward correcting means when the correction of the web position required of the feedback correcting means has grown and goes beyond its predetermined limits, indicating that there is a trend for the web to shift in one direction.

The accompanying drawings, which are incorporated in and form a part of this specification, illustrate an embodiment of the invention and, together with the description, serve to explain the principles of the invention. In the drawings:

Fig. 1 is a schematic diagonal view of an apparatus embodying the present invention;

Fig. 2 is a diagram for showing the function of the first correcting means;

Fig. 3 is a diagram for showing the function of the second correcting means;

Fig. 4 is a schematic for showing the positional relationship of the components of the apparatus of Fig. 1 and their roles played in correcting the position of the sheet;

Fig. 5 is a schematic for showing the positional relationship of the components of another apparatus embodying the invention and their roles played in correcting the position of the sheet; and

Fig. 6 is a schematic flow chart for the operation of the apparatus of Fig. 1.

The invention will be described as applied to a bag maker-packaging machine of a so-called vertical pillow type (described, for example, in U.S. Patent No. 5,174,096) with reference to Fig. 1 wherein numeral 1 indicates a sheet roll. An elongated web of sheet S, pulled out of this sheet roll 1, is transported longitudinally by means of a guide roll 2 extending parallel to the axis of the sheet roll 1 and a turn bar 4 which is disposed diagonally thereto. The turn bar 4 is for changing the direction of motion of the sheet S approximately by 90 degrees so as to head towards the former (not shown) of the bag maker for forming the sheet S into a tubular shape before bags are made therefrom. The turn bar 4 is provided with a first correction mechanism (later referred to also as the feed forward correcting means) 3 such as a servo motor so as to be able to move translationally, that is,

moving laterally without changing its direction of extension. When a sheet roll of a different width is loaded, the position of the turn bar 4 is thereby adjusted such that the center line of the sheet will correctly align with the former to which it is directed. The sheet S is further passed over a guide roll 6 and through a pair of somewhat obliquely disposed correction rolls 9 and 10, which serves as a second correcting means (later referred to also as the feedback correcting means), and then guided to a bag maker-packaging machine (not shown).

Fig. 2 shows how the turn bar 4 can adjust lateral displacements of the sheet S by moving translationally, as explained above, by means of the first correction mechanism 3. A feed forward sensor FFS is disposed upstream of the first correction mechanism 3 along the travel path of the sheet S for detecting the lateral displacement of the sheet S at its position and outputting a signal indicative of the detected displacement. Numeral 5 (shown in Fig. 1) indicates a first control circuit (later referred to also as a feed forward control means) adapted to control the first correction mechanism 3 according to this output signal from the feed forward sensor FFS.

With an apparatus thus structured, if the sheet S was not uniformly wound in the sheet roll 1 and undergoes a zigzag motion, moving back and forth transversely to the direction in which it is pulled, the feed forward sensor FFS, disposed on the upstream side of the first correction mechanism 3, detects it as a deviation from a target position  $x$  and successively outputs signals each indicating the magnitude of the displacement from the target position  $x$  at the moment. These signals are received by the first correction circuit 5 for controlling the first correction mechanism 3 by an open-loop control method and causing the turn bar 4 to move laterally as explained above to correct the transverse displacements of the sheet S due to its zigzag motion.

The correction thus made, as described above, is primarily of zigzag motion caused by the non-uniform way in which the sheet roll 1 has been wound. There are other causes, however, of the zigzag motion of the sheet S such as external disturbances. The aforementioned second correcting means, including the pair of correction rolls 9 and 10, is for correcting the zigzag motion due to such other causes. As shown in Fig. 3, the correction rolls 9 and 10 are for correcting lateral displacements of the sheet S by means of a second correction mechanism (later referred to also as the feedback correcting means) 8 of a kind disclosed, for example, in Japanese Patent Publication Tokkai 4-144871. This is to say that the second correction mechanism 8 may be so structured that a transverse displacement of the sheet S is corrected by

tilting links 11 for forming a parallelogram with the correction rolls 9 and 10 according to a detection signal outputted from a feedback sensor FBS which is disposed on the downstream side of the correction rolls 9 and 10 with respect to the direction of travel of the sheet S. Numeral 12 indicates a second control circuit (later referred to also as a feedback control means) adapted to control the second correction mechanism 8 according to this output signal from the feedback sensor FBS.

The correction of a zigzag motion by the first and second correction mechanisms 3 and 8 is schematically illustrated in Fig. 4 wherein the position of the sheet S in the direction transverse to its travel path is indicated by symbol  $\epsilon$  as a function of time  $t$ . As explained above, the correction made by the first correction mechanism may include a small error  $\Delta\epsilon$  due, for example, to external disturbances. As the sheet S reaches the position of the feedback sensor FBS on the downstream side of the second correction mechanism 8 (and preferably immediately before the sheet S reaches the former), the lateral displacement of the sheet S corresponding to this error  $\Delta\epsilon$  is detected (after the time  $T$  taken by the sheet S to travel the distance between the sensors FFS and FBS), and a signal indicative of this displacement is outputted to the second correction circuit 12, which controls the second correction mechanism 8 by a closed-loop method and thereby rotates the correction rolls 9 and 10 by an angle corresponding to the required correction so as to bring the sheet S accurately to the target position.

Fig. 5 shows another apparatus embodying the invention, characterized as having only one correction mechanism 23 on the travel path of the sheet S. A feed forward sensor FFS and a feedback sensor FBS are provided respectively on the upstream side and the downstream side of the correction mechanism 23, which is controlled by output signals from these two sensors FFS and FBS.

In Fig. 1, numeral 15 indicates a trend control means, representing another aspect of the invention, for coordinating the operations of the first and second correction circuits 5 and 12 where corrections by the second correction mechanism 8 are usually much smaller than those by the first correction mechanism 3. As shown in Fig. 6 which schematically illustrates the operations of the apparatus of Fig. 1 including the trend control means 15, the first and second correction circuits 5 and 12 use preset open-loop and closed-loop algorithms (symbolically represented by  $R_{FF}$  and  $R_{FB}$ , respectively) to operate the first and second correction mechanisms 3 and 8, (Steps S2 and S4), respectively, if the displacement detected by the FFS and FBS sensors are greater than a certain threshold value (YES in Steps S1 and S3, respectively). If the

correction to be effected by the second correction mechanism 8, corresponding to a detection signal outputted from the feedback sensor FBS, is outside its limit of control, the trend control means 15 interprets it as a trend for the sheet S to move more in one direction than in the other (YES in Step S5) and adjusts parameters which define the algorithm  $R_{FF}$  by which the first correction circuit 5 controls the first correction mechanism 3 corresponding to a detection signal outputted from the feed forward sensor FFS (Step S6). An equivalent of this trend control means 15 may be incorporated in the correction mechanism 23 of Fig. 5.

Although the present invention has been described above as applied to a sheet transporting device for a packaging machine, apparatus for correcting the zigzag motion of a web according to the present invention can also be used, for example, with a device for supplying paper to a printing machine using an elongated web.

In summary, zigzag motions of a longitudinally traveling web of sheet are corrected according to the present invention by detecting the transverse displacement of the sheet at an upstream position and making a correction by an open-loop method according to the magnitude of the detected displacement by a correcting means disposed on the downstream side of the sensor which detected the displacement. There may also be provided a second correcting mechanism operating on a feedback principle with a correcting means and a detection sensor disposed on the downstream side of the correcting means such that the correcting means based on the feed forward principle can quickly correct the displacement of the web by an open-loop method, and the correcting means on the downstream side makes an additional correction by a closed-loop method.

## Claims

1. An apparatus for correcting zigzag motion of an elongate web (S) being transported longitudinally along a path, said apparatus comprising:

feed forward correcting means (3), disposed on said path, for correcting lateral displacements of said web;

feed forward sensor means (FFS), disposed on said path on the upstream side of said feed forward correcting means (3), for detecting and outputting signals indicative of lateral displacements of said web at said feed forward sensor; and

feed forward control means (5) for receiving signals from said feed forward sensor means (FFS) and controlling operations of said feed forward correcting means (3) according to

said signals received from said feed forward sensor means.

2. The apparatus of claim 1, wherein said feed forward correcting means (3) include an elongate member (4) disposed diagonally to said path and serving to change the direction of motion of said elongate web approximately by 90 degrees, said elongate member being adapted to move translationally according to a signal from said feed forward control means (5).

3. The apparatus of claim 1 or claim 2, wherein said feed forward control means (5) controls said feed forward correcting means by an open loop correction method.

4. The apparatus of any of the preceding claims, further comprising:

feedback correcting means (9,10) disposed on said path and on the downstream side of said feed forward sensor means (FFS), for correcting lateral displacements of said web;

feedback sensor means (FBS), disposed on said path on the downstream side of said feedback correcting means (3), for detecting and outputting signals indicative of lateral displacements of said web at said feedback sensor means; and

feedback control means (12) for receiving signals from said feedback sensor means and controlling operations of said feedback correcting means according to signals received from said feedback sensor means.

5. The apparatus of claim 4, wherein said feedback control means (12) controls said feedback correcting means by a closed loop correction method.

6. Apparatus according to claim 4 or claim 5, wherein the feedback and feed forward correcting means are defined by a common correcting device (23).

7. The apparatus of any of claims 4 to 6, further comprising trend control means (15) for controlling said feed forward control means (5) according to outputs from said feedback sensor means (FFS).

8. The apparatus of claim 7, wherein said trend control means (15) adjust control parameters used by said feed forward control means (5) when outputs from said feedback sensor means (FBS) indicate that the correction to be effected by said feedback correcting means

(9,10) corresponding to said outputs is 'beyond limits of said feedback correcting means.

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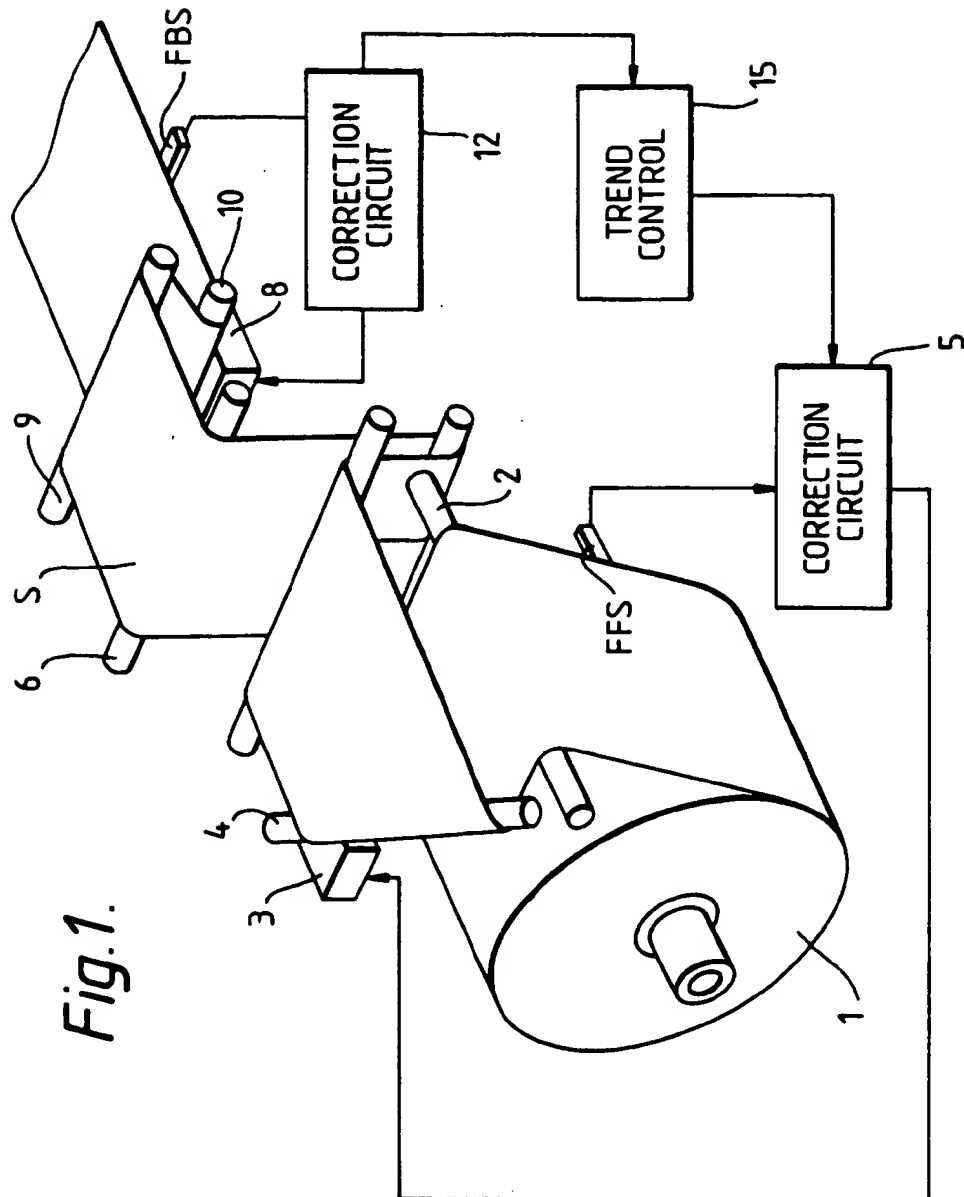


Fig. 1.

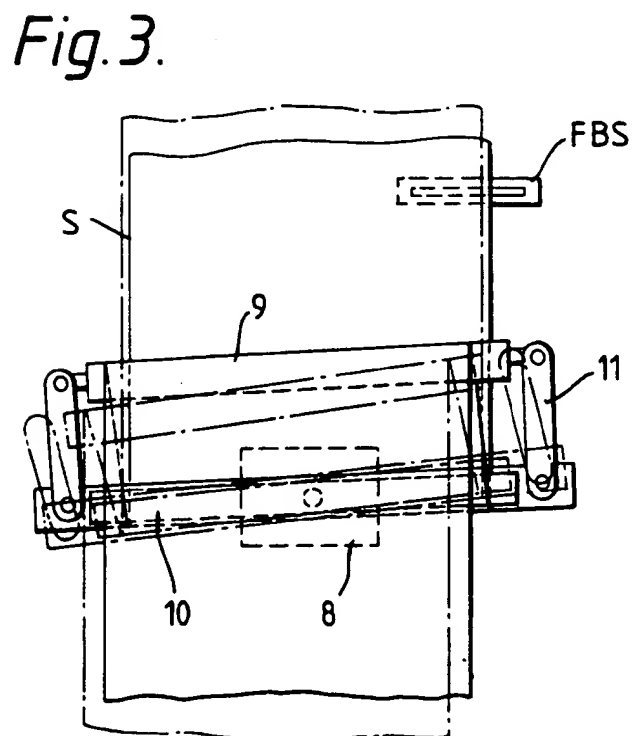
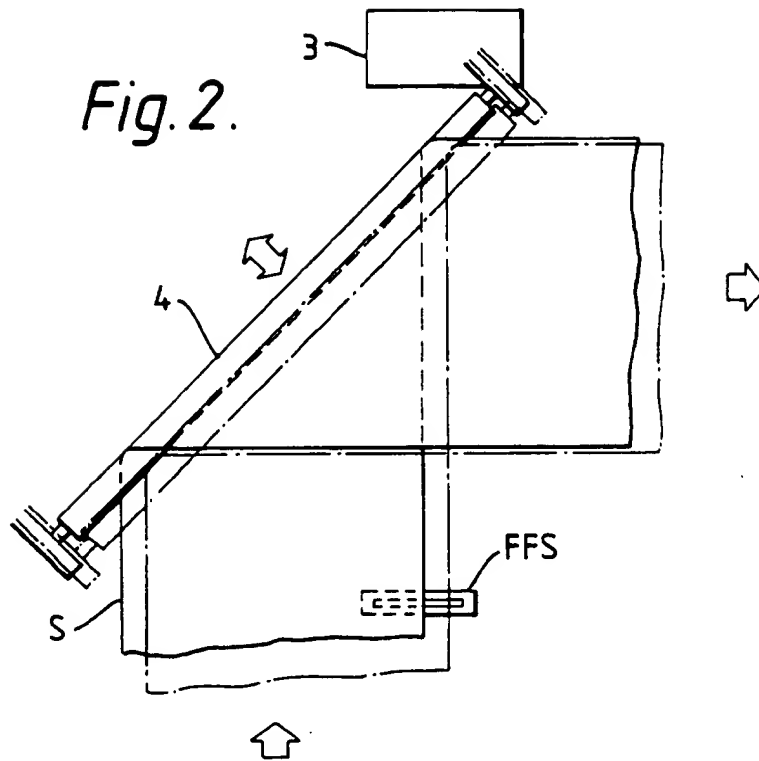


Fig.4.

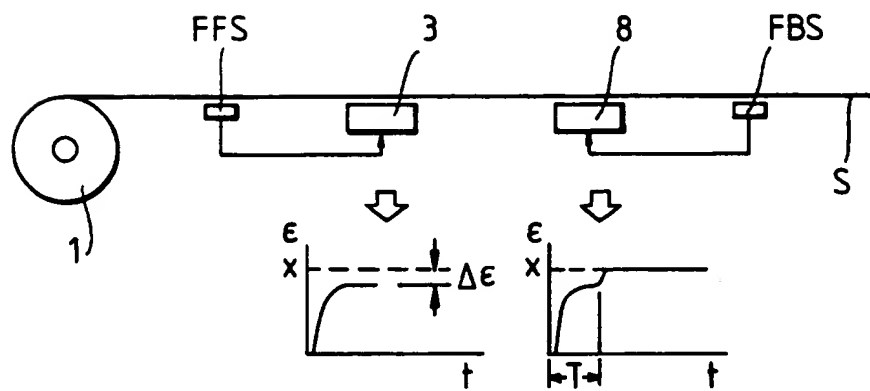


Fig.5.

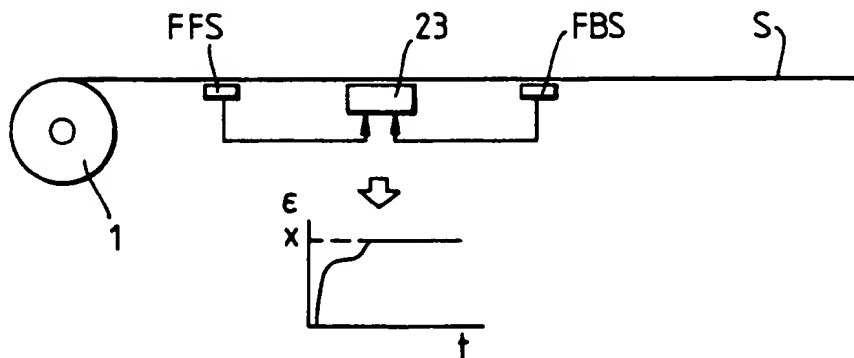
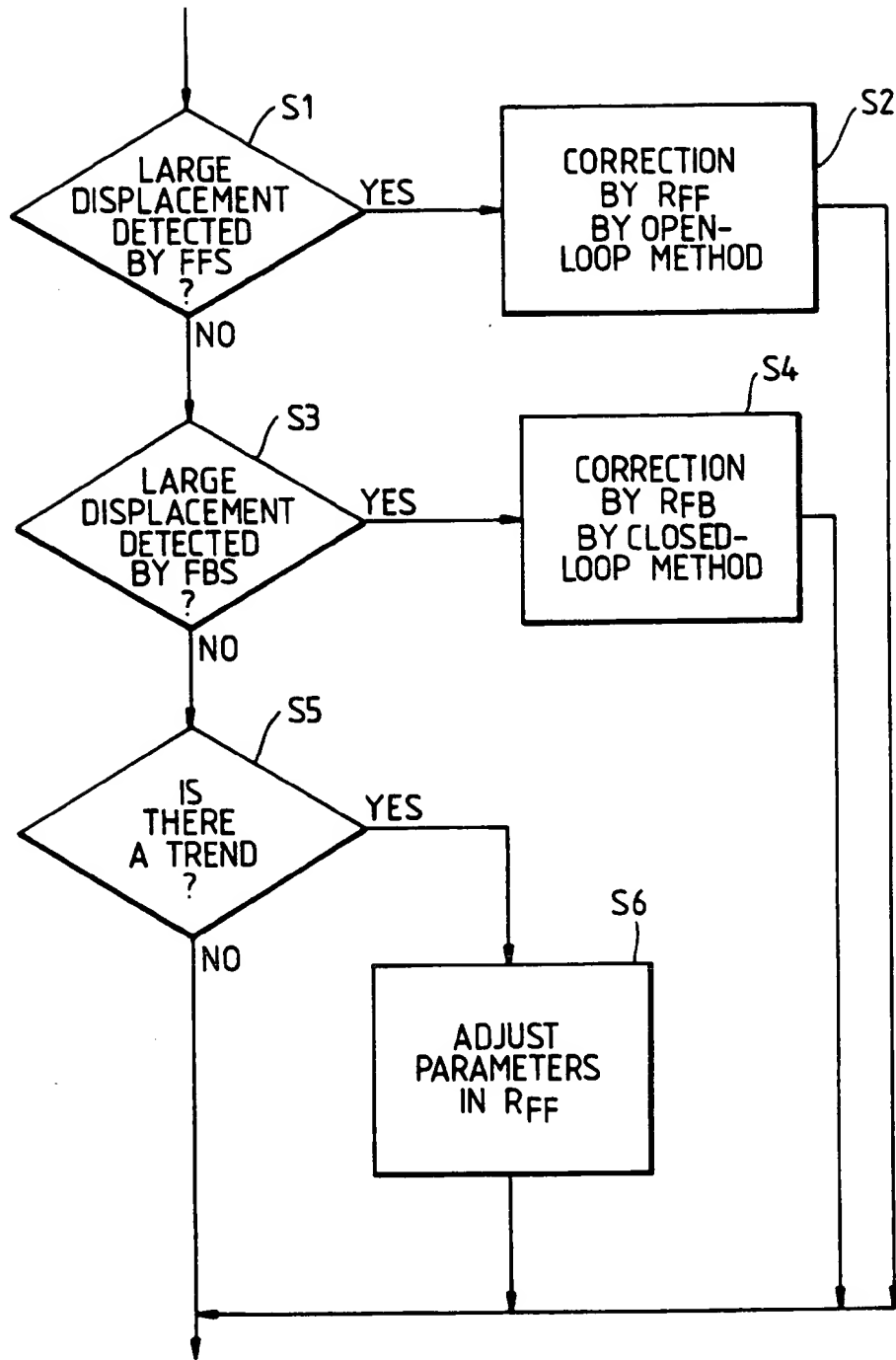




Fig. 6.





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## EUROPEAN SEARCH REPORT

Application Number  
EP 93 30 9904

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
D,Y	EP-A-0 479 594 (ISHIDA SCALES MFG. CO., LTD.) & US 5,174,096 * the whole document *	1-6,8	B65H23/038
D,A	---	7	
Y	GB-A-2 191 608 (VEB KOMBINAT POLYGRAPH "WERNER LAMBERZ" LEIPZIG) * the whole document *	1-6,8	
A	---	7	
D,A	US-A-4 049 213 (HANK; LIPFERT; NIESGODA) * the whole document *	1-8	
A	---		
A	DE-A-20 62 281 (FUJI PHOTO FILM CO. LTD.) ---	1-8	
A	US-A-3 095 131 (ROBERTSON; FOSTER) -----	1-8	
			TECHNICAL FIELDS SEARCHED (Int.Cl.5)
			B65H
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
THE HAGUE		25 April 1994	Madsen, P
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